Estimating Greenhouse Gas Emission Reductions from Source Reducing or Recycling Selected Materials:

Instructions, Worksheet, and Lookup Tables

INTRODUCTION

The following instructions and lookup tables are intended for use by participants in the U.S. Department of Energy, Energy Information Administration's Voluntary Reporting of Greenhouse Gases Program. The lookup tables have been created by the U.S. Environmental Protection Agency's Office of Solid Waste to assist program participants in estimating greenhouse gas emission reductions from projects involving source reduction[1] or recycling of any of the following materials:

• Newspaper	• Mixed Paper[2] (recycling only)	• HDPE Plastic
• Office Paper	• Aluminum Cans	• LDPE Plastic
• Corrugated Cardboard	• Steel Cans	• PET Plastic

The greenhouse gas emission reduction estimates that appear in the attached lookup Tables 1-4 are based on life-cycle values, and include (1) energy savings from reduced manufacture of the material or manufacture with recycled inputs, (2) avoided landfill methane emissions for paper products (because most of these materials, if not source reduced or recycled, would be landfilled), (3) forest carbon sequestration for paper products,[3] and (4) avoided emissions of methane and other gases due to reduced manufacture. All reduction estimates assume that waste materials would have otherwise been disposed of in landfills.[4]

Landfills may manage the gas produced from waste decomposition differently. They may allow the gas to vent to the atmosphere, they may capture the gas and flare it, or they may capture the gas and use it as an energy source. Estimates of emission reductions associated with source reduction and recycling differ depending on what method of gas management is employed by the landfill where the

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[1] Source reduction, also known as waste reduction, is defined here as using less of a given material without using more of some other material—e.g., making aluminum cans with less aluminum ("lightweighting"), or using less office paper by switching from single-sided to double-sided photocopying.

[2] Mixed paper as defined here includes office paper, non-corrugated paper boxes, and paper packaging but excludes newspaper and corrugated boxes (because these are typically recycled separately).

[3] This is reported as a reduction in CO_2 emissions.

[4] For a complete discussion of how the emission values shown in Exhibits J-3 and J-4 were calculated, please see the US Environmental Protection Agency report *Greenhouse Gas Emissions from Management of Selected Materials in the Municipal Solid Waste Stream* (US EPA Office of Solid Waste, 1998 [in progress]).

waste would have been disposed. It will be useful to determine which category of landfill is appropriate for comparison when calculating your emission reductions. If you do not know the landfill gas management status of the landfill, you may use the estimates provided for the national average landfill.

The timing of greenhouse gas emissions (and emission reductions) associated with waste management of paper products is quite complicated. Because the1605(b) Voluntary Reporting Program is designed to record achieved reductions, lookup Tables 1 and 2 represent a simplified approach to capturing the variation in emissions over time from several processes associated with paper product source reduction and recycling. Specifically, landfill methane generation (and reduced utility emissions when methane is used to generate electricity), long-term storage of carbon in landfills, and effects on forest carbon storage all occur over a period of many years. To ease use of the lookup tables, these processes are assumed to start in year 1 (the year in which the source reduction or recycling occurs) and proceed at a constant rate for 15 years. Thus, the annual emission factors for paper products in lookup Tables 1 and 2 represent the long-term effect of these processes on emissions, divided by 15 years. All other emissions are characterized as occurring in year 1. For reference, total emission reductions (over the long term) for each greenhouse gas are shown in lookup Tables 3 and 4.

INSTRUCTIONS

Complete the following steps to determine the greenhouse gas emission reductions for any given year associated with a source reduction or recycling project. Please see below for sample worksheet.

Column	Step
A	Identify the material source reduced or recycled.
B	Enter the year the source reduction or recycling occurred.
C	Enter an “S” if the material was source reduced or an “R” if the material was recycled.
D	Enter the quantity source reduced or recycled, measured in short tons.
E	- Insert a “1" if you are comparing to a landfill without gas recovery or a landfill that recovers and flares gas. - Insert a “2" if you are comparing to a landfill that recovers gas for electric generation. - Insert a “3" if you are estimating reductions relative to the national average landfill.
F	- For materials *source reduced* in the year being reported, multiply the quantity of material in Column D by the appropriate “year 1" emission reduction factor for carbon dioxide in the column on Table 1 that corresponds to the landfill comparison selected in Column E. - For materials *recycled* in the year being reported, multiply the quantity of material in Column D by the appropriate “year 1" emission reduction factor for carbon dioxide in the column on Table 2 that corresponds to the landfill comparison selected in Column E.
G (Paper Products Only)	- For paper products *source reduced* in the years prior to that being reported, multiply the quantity of material in Column D by the appropriate “year 2-15" emission reduction factor for carbon dioxide in the column on Table 1 that corresponds to the landfill comparison selected in Column E. - For paper products *recycled* in the years prior to that being reported, multiply the quantity of material in Column D by the appropriate “year 2-15" emission reduction factor for carbon dioxide in the column on Table 2 that corresponds to the landfill comparison selected in Column E.

H	- For materials *source reduced* in the year being reported, multiply the quantity of material in Column D by the appropriate "year 1" emission reduction factor for methane in the column on Table 1 that corresponds to the landfill comparison selected in Column E. - For materials *recycled* in the year being reported, multiply the quantity of material in Column D by the appropriate "year 1" emission reduction factor for methane in the column on Table 2 that corresponds to the landfill comparison selected in Column E.
I (Paper Products Only)	- For paper products *source reduced* in the years prior to that being reported, multiply the quantity of material in Column D by the appropriate "year 2 -15" emission reduction factor for methane in the column on Table 1 that corresponds to the landfill comparison selected in Column E. - For paper products *recycled* in the years prior to that being reported, multiply the quantity of material in Column D by the appropriate "year 2-15" emission reduction factor for methane in the column on Table 2 that corresponds to the landfill comparison selected in Column E.
J-K (Aluminum Cans Only)	- For aluminum cans *source reduced* in the year being reported, multiply the quantity of material in Column D "year 1" emission reduction factors for CF_4 and C_2F_6 shown in Table 1. - For aluminum cans *recycled* in the year being reported, multiply the quantity of material in Column D "year 1" emission reduction factors for CF_4 and C_2F_6 shown in Table 1.
L-M	Sum the total reductions estimated in each column. Add the total in Columns F and G and enter the sum in L. Add the total in Columns H and I and enter the sum in M.

You now have estimates of carbon dioxide, methane, CF_4 and C_2F_6 emission reductions for the year chosen in units of metric tons. This data can be transferred to Form EIA-1605, Schedule II, Section 10. Annual quantities of material source reduced or recycled should be entered in Part II, Question 3. Emission reductions should be reported as positive reductions in Part III.

Source Reducing and Recycling Worksheet (Sample)

Reporting year: 1997

A. Material	**B.** Year of Reduction	**C.** Project Type	**D.** Quantity (Short Tons)	**E.** Landfill Comparison	**F.** CO_2 - Year 1 (Met. Tons)	**G.** CO_2 - Year 2 - 15 (Met. Tons)	**H.** CH_4 - Year 1 (Met. Tons)	**I.** CH_4 - Year 2 -15 (Met. Tons)	**J.** CF_4 (Met. Tons)	**K.** C_2F_6 (Met. Tons)
Newspaper	1997	R	100	2	175		0.3			
Newspaper	1996	R	50	2		5		0.05		
Office Paper	1997	S	200	2	200		1			
Office Paper	1996	S	100	2		38		0.3		
Aluminum Cans	1997	R	80	2	691		1.12		0.24	0.024
Total (Metric Tons)					1,066	43	2.42	0.35	0.024	0.024
					L. Sum CO_2 = 1,109		**M.** Sum CH_4 = 2.77			

Source Reducing and Recycling Worksheet

Reporting year:

A. Material	**B.** Year of Reduction	**C.** Project Type	**D.** Quantity (Short Tons)	**E.** Landfill Comparison	**F.** CO_2 - Year 1	**G.** CO_2 - Year 2 - 15 (Met. Tons)	**H.** CH_4 - Year 1 (Met. Tons)	**I.** CH_4 - Year 2 -15 (Met. Tons)	**J.** CF_4 (Met. Tons)	**K.** C_2F_6 (Met. Tons)
Total (Metric Tons)										
					L. Sum CO_2 =		**M.** Sum CH_4 =			

Table 1. Greenhouse Gas Effects of *Source Reducing* Various Waste Materials Relative to Landfilling the Materials* (Metric Tons (MT) of Gas Per Short Ton of Product Source Reduced)

	CO2 Emissions (MT/Ton of Product)						CH4 Emissions(MT/Ton of Product)						CF_4 Emissions (MT/Ton of Product)	C_2F_6 Emissions (MT/Ton of Product)
	Relative to (a) Landfills Without LFG Recovery or (b) Landfills With LFG Recovery and Flaring		Relative to Landfills With LFG Recovery and Electricity Generation		Relative to the National Average Landfill		Relative to Landfills Without LFG Recovery		Relative to (a) Landfills With LFG Recovery and Flaring or (b) Landfills With LFG Recovery and Electricity Generation		Relative to the National Average Landfill			
Waste Component	Year 1	Year 2-15**	Year 1	Year 2-15**	Year 1	Year 2-15**	Year 1	Year 2-15**	Year 1	Year 2-15**	Year 1	Year 2-15**	Year 1	Year 1
Newspaper	1.76	0.019	1.75	0.010	1.76	0.018	0.006	0.003	0.003	0.001	0.005	0.002	0.00	0.00
Office Paper	2.04	0.117	2.00	0.076	2.04	0.111	0.015	0.013	0.005	0.003	0.013	0.011	0.00	0.00
Mixed Paper (Broad)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Cardboard	1.50	0.041	1.48	0.023	1.50	0.038	0.008	0.006	0.003	0.001	0.007	0.005	0.00	0.00
Aluminum Cans	8.64	0.000	8.64	0.000	8.64	0.000	0.014	0.000	0.014	0.000	0.014	0.000	0.0003	0.00003
Steel Cans	3.09	0.000	3.09	0.000	3.09	0.000	0.003	0.000	0.003	0.000	0.003	0.000	0.00	0.00
HDPE	2.09	0.000	2.09	0.000	2.09	0.000	0.010	0.000	0.010	0.000	0.010	0.000	0.00	0.00
LDPE	3.03	0.000	3.03	0.000	3.03	0.000	0.014	0.000	0.014	0.000	0.014	0.000	0.00	0.00
PET	3.36	0.000	3.36	0.000	3.36	0.000	0.008	0.000	0.008	0.000	0.008	0.000	0.00	0.00

*Assuming Source Reduction displaces the current mix of virgin and recycled inputs in the manufacture of the material

** All emissions are equal to zero after Year 15.

Source: U.S. Environmental Protection Agency, Office of Solid Waste

Table 2. Greenhouse Gas Effects of *Recycling* Various Waste Materials Relative to Landfilling the Materials (Metric Tons (MT) of Gas Per Short Ton of Product Recycled)

	CO2 Emissions (MT/Ton of Product)						CH4 Emissions(MT/Ton of Product)						CF_4 Emissions (MT/Ton of Product)	C_2F_6 Emissions (MT/Ton of Product)
	Relative to (a) Landfills Without LFG Recovery or (b) Landfills With LFG Recovery and Flaring		Relative to Landfills With LFG Recovery and Electricity Generation		Relative to the National Average Landfill		Relative to Landfills Without LFG Recovery		Relative to (a) Landfills With LFG Recovery and Flaring or (b) Landfills With LFG Recovery and Electricity Generation		Relative to the National Average Landfill			
Waste Component	Year 1	Year 2-15*	Year 1	Year 2-15*	Year 1	Year 2-15*	Year 1	Year 2-15*	Year 1	Year 2-15*	Year 1	Year 2-15*	Year 1	Year 1
Newspaper	0.57	0.092	0.57	0.083	0.57	0.090	0.003	0.003	0.001	0.001	0.003	0.002	0.00	0.00
Office Paper	0.53	0.169	0.49	0.129	0.52	0.164	0.013	0.013	0.003	0.003	0.011	0.011	0.00	0.00
Mixed Paper (Broad)	(0.15)	0.124	(0.17)	0.105	0.16	0.122	0.006	0.006	0.001	0.002	0.005	0.005	0.00	0.00
Corrugated Cardboard	0.06	0.124	0.04	0.107	0.06	0.122	0.005	0.006	0.001	0.001	0.004	0.005	0.00	0.00
Aluminum Cans	10.27	0.000	10.27	0.000	10.27	0.000	0.015	0.000	0.015	0.000	0.015	0.000	0.0005	0.00005
Steel Cans	2.10	0.000	2.10	0.000	2.10	0.000	0.002	0.000	0.002	0.000	0.002	0.000	0.00	0.00
HDPE	1.18	0.000	1.18	0.000	1.18	0.000	0.010	0.000	0.010	0.000	0.010	0.000	0.00	0.00
LDPE	1.64	0.000	1.64	0.000	1.64	0.000	0.010	0.000	0.010	0.000	0.010	0.000	0.00	0.00
PET	2.18	0.000	2.18	0.000	2.18	0.000	0.007	0.000	0.007	0.000	0.007	0.000	0.00	0.00

* All emissions are equal to zero after Year 15.

Source: U.S. Environmental Protection Agency, Office of Solid Waste

Table 3. Present Value Greenhouse Gas Effects of *Source Reducing* Various Waste Materials Relative to Landfilling the Materials* (Metric Tons (MT) of Gas Per Short Ton of Product Source Reduced)

Waste Component	CO2 Emissions (MT/Ton of Product)			CH4 Emissions(MT/Ton of Product)			CF_4 Emissions (MT/Ton of Product)	C_2F_6 Emissions (MT/Ton of Product)
	Relative to (a) Landfills Without LFG Recovery or (b) Landfills With LFG Recovery and Flaring	Relative to Landfills With LFG Recovery and Electricity Generation	Relative to the National Average Landfill	Relative to Landfills Without LFG Recovery	Relative to (a) Landfills With LFG Recovery and Flaring or (b) Landfills With LFG Recovery and Electricity Generation	Relative to the National Average Landfill		
Newspaper	2.02	1.89	2.01	0.043	0.013	0.038	0.000	0.000
Office Paper	3.68	3.07	3.60	0.192	0.050	0.166	0.000	0.000
Mixed Paper (Broad)	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Cardboard	2.07	1.80	2.04	0.086	0.023	0.075	0.000	0.000
Aluminum Cans	8.64	8.64	8.64	0.014	0.014	0.014	0.0003	0.00003
Steel Cans	3.09	3.09	3.09	0.003	0.003	0.003	0.000	0.000
HDPE	2.09	2.09	2.09	0.010	0.010	0.010	0.000	0.000
LDPE	3.03	3.03	3.03	0.014	0.014	0.014	0.000	0.000
PET	3.36	3.36	3.36	0.008	0.008	0.008	0.000	0.000

*Assuming Source Reduction displaces the current mix of virgin and recycled inputs in the manufacture of the material.
Source: U.S. Environmental Protection Agency, Office of Solid Waste

Table 4. Present Value Greenhouse Gas Effects of *Recycling* Various Waste Materials Relative to Landfilling the Materials (Metric Tons (MT) of Gas Per Short Ton of Product Recycled)

Waste Component	CO2 Emissions (MT/Ton of Product)			CH4 Emissions(MT/Ton of Product)			CF_4 Emissions (MT/Ton of Product)	C_2F_6 Emissions (MT/Ton of Product)
	Relative to (a) Landfills Without LFG Recovery or (b) Landfills With LFG Recovery and Flaring	Relative to Landfills With LFG Recovery and Electricity Generation	Relative to the National Average Landfill	Relative to Landfills Without LFG Recovery	Relative to (a) Landfills With LFG Recovery and Flaring or (b) Landfills With LFG Recovery and Electricity Generation	Relative to the National Average Landfill		
Newspaper	1.86	1.73	1.84	0.041	0.011	0.036	0.000	0.000
Office Paper	2.89	2.29	2.81	0.190	0.048	0.163	0.000	0.000
Mixed Paper (Broad)	1.58	1.29	1.55	0.091	0.022	0.079	0.000	0.000
Corrugated Cardboard	1.80	1.53	1.77	0.084	0.020	0.072	0.000	0.000
Aluminum Cans	10.27	10.27	10.27	0.015	0.015	0.015	0.0005	0.00005
Steel Cans	2.10	2.10	2.10	0.002	0.002	0.002	0.000	0.000
HDPE	1.18	1.18	1.18	0.010	0.010	0.010	0.000	0.000
LDPE	1.64	1.64	1.64	0.010	0.010	0.010	0.000	0.000
PET	2.18	2.18	2.18	0.007	0.007	0.007	0.000	0.000

Source: U.S. Environmental Protection Agency, Office of Solid Waste